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# Competencies to move beyond eco-efficiency

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**Abstract**

Organisations are exploring new sustainable business models to prepare for a fundamentally different operating environment. Eco-efficiency and eco-technology in eco-factories has been the actions taken by most firms. Beyond this the next steps appears to be the complete reconfiguration of the industrial system and business models. Organisations currently lack understanding of possible futures and where to focus efforts to inform planning. There is a need to develop the know-how to enable changes across the whole industrial system and to identify system-wide opportunities. This paper aims to rethink how manufacturing industry can perform sustainably in a changing world. The paper presents competencies needed to enable business to look beyond eco-efficiency to plan for a sustainable & resilient future. The results of exploratory case studies observed through document analysis and interviews provide insights on organisations transforming from eco-efficiency to eco-effective system.



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*Keywords:* Industrial sustainability; competencies; eco-efficiency; sustainable business models.

## 1. Introduction

The unintended consequence of industrialisation is now evident, consequences that result from exceeding sustainable levels of raw material extraction, emissions and waste and the linear business model of take-make-use-waste. It is predicted manufacturing is set to enter a dynamic new phase, driven by rapid changes in technology, new ways of doing business, and potential volatility around the price and availability of resources [1]. It is suggested that eco-efficiency is necessary, but not sufficient. Manufacturers will also need to explore new ways of doing business. Business models need to be developed that support the simultaneous reduction in impacts across inter-related sustainability dimensions and scale social barriers to the adoption of new ways of consuming [2]. We argue that Industrial Sustainability will not be achieved simply by new technology: the configuration of the industrial system will need to change dramatically, introducing new concepts such as cradle-to-cradle [3], slow manufacturing, local manufacturing [4]; [5] and challenging today's business models [6]; [7]; [8]. Society must also play a role [9] as we explore new forms of value. Following on from eco-efficiency and eco-factory programmes, those organisations, which seek to lead in this field, are already beginning to explore what the new shapes of the industrial system may be [10].

### 1.1 Research question

A sustainable future is one, which delivers shared and long-term success economically, environmentally and socially. The objective of this research is to identify key competences for industry actors to focus efforts to plan transformation to a more sustainable industrial system. The paper investigates; what competencies enable transforming from eco-efficiency to eco-effective system?

## 2. Literature Review

The literature review explores three research domains; industrial sustainability, sustainable business models and competencies for sustainability.


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### 2.1 Industrial sustainability

Graedel [11], McDonough & Braungart [3], Robèrt [12] state that significant changes to the way we think about the industrial system are needed in order to make it sustainable. It is argued that it is essential to look at the entire system of designing, making and serving to achieve the level of environmental performance change that is needed Senge [13]. From an industrial design perspective this means developing materials, products, supply chains, and manufacturing processes that replace industry's linear business (make-produce-sell-use-throwaway) model and transform to a closed loop business model (cradle-to-cradle) [3].

Robèrt [12] describes 4 system conditions of a Sustainable Society;

- Concentrations of substances extracted from the Earth's crust; substances from the earth's crust must not systematically increase in the ecosphere, which means that fossil fuels, metals and other minerals must not be extracted at a faster pace than their slow redeposit and reintegration into the Earth's crust.
- Concentrations of substances produced by society; substances produced by society must not systematically increase in the ecosphere. Nature cannot withstand a systematic buildup of substances produced by humans. It is suggested substances must not be produced at a faster pace than they can be broken down and integrated into the cycles of nature or deposited into the Earth's crust.
- Degradation by physical means, and in that society; the physical basis for productivity and diversity of nature must not be systematically diminished. Nature cannot withstand a systematic deterioration of its capacity for renewal.
- People are not subject to conditions that systematically undermine their capacity to meet their needs; the three previous conditions to be met, there must be fair and efficient use of resources with respect to meeting human needs.

Industrial Ecology (IE) is a metaphor for how industry can learn from observations about how species interact and materials flow within natural ecosystems and at the higher system level the biosphere (Frosch and Gallopoulous [14], Ayres [15], Scolow [16]; Clift [17]; Deutz and Gibb [18]). Its aim is to align industrial processes with 'material flows in living systems' [18], through the reorganisation of firms into 'industrial ecosystems' [19]. Thomas et al [20] highlights the three specific dimensions of the industrial ecology metaphor put forward by both Frosch and (Gallopoulous [13] and Ayres [14] as; the optimisation of energy and materials within an industrial system; the minimisation of waste and the exchange of by-products from one production process as an input in another [20].

The key concepts that emerge from industrial ecology is the idea of the waste or the output of one organism in nature being the input or food for another organism namely the idea of 'waste equals food'. However, Braungart et al. [3] also emphasises the fact that the concept of waste does not even exist in nature at all. The idea of designing out waste goes beyond the concept of de-materialization – merely doing more from less material input [3], to designing out aspects of products or industrial processes that produce outputs that cannot be cycled and re-used safely in the techno sphere Robért [12] as technical nutrients or enter the biosphere as biological nutrients [3]. It appears that resource constraints and environmental concerns such as water scarcity together with other factors will influence the potential location of our factories and the business models they operate in the near future. Concepts such as circularity, systems thinking and whole system design are proposed in the sustainability literature as providing compelling principles on which future industrial systems might be built. However application of these models is scarce, and practitioners lack understanding od capabilities needed for planning for such transformation to sustainable industrial systems.

Fernando & Evans [21] states sustainability frameworks by pioneering authors help managers and decision makers to shift their attention from eco-efficiency (less bad) to eco-effectiveness (more good). It also highlights for businesses to put the sustainability framework into practice they need both the right technologies and the right strategies, and capabilities.

### 2.2 Sustainable business models

Orgnaisations today are challenged to contribute to sustainable development on the individual, organizational and societal level. Sustainability management refers to approaches dealing with social, environmental and economic issues in an integrated manner to transform organizations in a way that they contribute to a sustainable development of the economy and society within the limits of the ecosystem (e.g. Schaltegger & Burritt [22]; Starik & Kanashiro [23]). It appears "technological fix" – are insufficient to create the required transformation of organizations, industries and societies towards more sustainability. Researchers and practitioners are therefore increasingly exploring how completely new business models can help maintain or even increase economic prosperity by either radically reducing negative or creating positive external effects for the natural environment and society (e.g. Boons & Lüdeke-Freund [24]; Hansen et al. [25]; Schaltegger et al.[22]; Stubbs & Cocklin, [26]). This perspective does not only cover existing organizations and how their business models are transformed (e.g. Sommer [27]), but also entirely new business models pioneered by entrepreneurs. The literature on sustainable business models is still emerging. A business model is described as the design or architecture of the value creation, delivery and capture mechanism of a firm - how the firm delivers value, how it attracts customers, and how it converts this to profit (Teece [30]). Richardson [29] proposes the concept of value proposition:

a) The value proposition: offering, target customer, differentiation;
b) The value creation and delivery system: the value

chain required, resources, assets, processes, position in the value network relative to customers, competitors and collaborators;

c) The value capture system: how the firm makes money (financial model) and competitive strategy.

Business model innovation offers a potential approach to deliver the required change through re-conceptualising the purpose of the firm and the value creating logic, and rethinking perceptions of value. The assertion is that with careful business model redesign it is possible for mainstream businesses to more readily integrate sustainability into their business and for new start-ups to design and pursue sustainable business from the outset, as suggested by Stubbs and Cocklin [26] and business model innovations can support a systematic, on-going creation of business cases for sustainability (Schaltegger et al. [22]).

### 2.3 Competencies for sustainability

The literature on competencies and competencies in sustainability in specific comprises of a variety of terminological ambiguity, authors have linked the term ‘‘competencies’’ with abilities, capabilities, roles, experiences and other concepts [31]. Boyatzis [32] and McLagan [33] are some of the early investigators of competencies. Recently in the last decade, there has been interest in conceptualizing key competencies in sustainability (Byrne [34]; De Haan [35]; Barth [36]; Sipos [37]; Segalas [38]; Willard [39]. Dentoni [40] proposes a framework consisting of seven competencies required for professionals who are actively involved in dealing with sustainability in their work environment; systems thinking competence, embracing diversity and inter disciplinarily competence, foresighted thinking competence, normative competence, Interpersonal competence, strategic management competence. Senge [41] proposes three core-learning capabilities; seeing systems, collaborating across boundaries and creating desired futures for systemic change. The author argues that these capabilities are needed for creating regenerative organisations, industries and economies and states that if you take away one the whole fails. The authors agrees with this view that without the capacity to see systems and their place in them, people and organisations will naturally focus on optimising their piece of the puzzle rather than building shared understanding and a larger vision.

From the literature reviewed it appears there is a lack of evidence on how manufacturing practitioners are using these competencies. The use of system thinking and whole system design competencies appear to be essential competencies for systemic change. However, there is a lack of knowledge and literature on what works and what does not work, and which competencies are used by practitioners to plan for a sustainable future.

## 3.0 Research method

To investigate the research question: ’What competencies enable transforming from eco-efficiency to eco-effective system?’ a literature review and exploratory case study was conducted. The literature review explores 3 research domains; industrial sustainability, sustainable business models and competencies for sustainability. The cross sector case study is used to observe and identify key competences, by exploring what works and what does not work. Due to the significant focal firm engagement required, and the complexity associated with the broad scope and data set to be reviewed, a case study analysis was deemed appropriate. As a research method used to generate and test theory, it is appropriately applied when research addresses exploratory questions and aims to produce a first-hand understanding of complex phenomena. Given the limited number of cases that can be studied, it is important to select critical, extreme and revelatory cases, in which the phenomenon is ‘transparently observable’ [42]; [43].

Five firms were selected that represented a range of industrial sectors that have actively invested in sustainability initiative, strategies and practice and provide evidence on key competencies used. The case studies selected exhibit a relatively mature level of performance within the sector. The case studies chosen are organisation that had unique business strategies for each competency explored, with complex multi-domestic footprints and with some level of published sustainability credentials (i.e. that might support advanced sustainability performance). In addition, data availability and accessibility were determinant factors in the case selection process. Each case complemented the others by replicating the findings under various conditions or by addressing different aspects. The goal was that together the set of case studies will provide empirical evidence for the phenomenon under investigation. The use of multiple data collection instruments within the research methods assisted with triangulation of data, thereby strengthening the largely qualitative outcomes of the research. Moreover, it supported the reliability and validity of the findings. The applied data collection tools include semi-structured interviews with open questions and documentation reviews. Interviews were conducted with a cross-functional group of senior management respondents of the focal firms, including senior management and environmental lead roles. Interview responses were recorded and mapped. All interview notes were sent immediately for comment, with further analysis fed back to participants. The approach was set up to ensure that there is both a discussion and consistent output across the case study firms. The findings were further reviewed against secondary data from published reports. The epistemological positioning of the research and the framework development and case study protocol used in this research meet the validity strategies suggested by Creswell and Miller [42] including triangulation, member checking and the audit trail.

## 4.0 Case study findings

This section provides an introduction to the exploratory case studies and highlights what the companies are doing to improve the sustainability performance.

### 4.1 Introduction to exploratory case studies

**Case A:** A well-reputed automobile company with a global footprint, known for its sustainability credentials industry-wide and for its ability to reduce waste. The company has been able to achieve zero waste to landfill, waste water recycling and 75% reduction in energy to make each vehicle. The automobile company was able to reduce their energy bill by seeing waste better; they used their expertise (the kaizen muscle) to systematically reduce their energy. The company is found to have by setting challenging targets to reduce environmental impact able to find creative ways to recycling wastewater, sending zero waste to landfill. (Company A, 2015), Interview data)

**Case B:** The company is a fast moving consumer good (FMCG), Sugar manufacturer. The company aims to transform all raw materials into sustainable products. The plant in Wissington has been operating for over 85 years and now produces over 420 kt of sugar annually for food and drinks manufacturers The company uses a culture of innovation to reduce process inputs, minimise waste and deliver its commitment to be an advanced and sustainable manufacturer. The case company has been able to find ways of internalising and being very effective at it. The company converts raw beet to sugar and the byproducts are used to produce electricity, tomatoes, animal feed, and other materials. No material arriving into the company is allowed to disappear as waste (and a cost). Instead all materials are turned into valuable co-products, including the soil attached to the beet, which becomes clean soil for gardeners, these actions contribute to a very high level of efficient use of raw materials. The company has been able to bring more value under its control and link knowledge to benefit by turning everything into a valuable output. (Company B, 2015), Interview data)

**Case C:** A major British multinational retailer. The company's sells clothing for men, woman and children, as well as home products and food. The organisation launched a strategic initiative called 'Plan A' to help protect the planet by sourcing responsibly, reducing waste and helping communities. The aim was to become carbon neutral, send no waste to landfill, extend sustainable sourcing, help improve the lives of people in their supply chain and help customers and employees live a healthier life-style. This was done by setting out 100 commitments to achieve in 5 years in 2007. The company now has introduced Plan A 2020. Which consists of 100 new, revised and existing commitments, with the ultimate goal of becoming the world's most sustainable major retailer. In addition to tackling sustainability challenges with its supply chain partners and manufactures. The organisation is found to with new collaboration and relationships with a charity organisation (unusual partner) was able to implement a model called "shwopping" (buy one, give one culture). The business model allows unwanted items to be resold, reused or recycled by a charity partner. This case study illustrates by collaborating and coordinating with unusual partners and expanding the system boundary, solutions to issues such as waste to landfill can start to be addressed. (Company C, 2015), Interview data)

**Case D:** A SME automobile company that aims to produce mobility at zero cost to the planet. The company offers a new business model and takes a systems view to create new forms of value. Sells mobility to driver and they pay for the fuel. This unlocks a new value system that allows them to build 250-mpg (e) cars. The organisation offers an innovative business model where the company sells mobility by charging customers a fee per month and per kilometer, the company then pay for the fuel. The case company offers an example of how it has found advantageous connections across the system and illustrates maturity in the whole systems design competency. The car company, by taking a systems view, internalised the fuel cost, the company pays for the fuel and customer the distance traveled. The company was able to look for win-win interactions. (Company D, 2015), Interview data)

**Case E:** The company is a privately owned manufacturing operation specializing in the manufacture of premium denim, with a capacity of over 6 million garments per year. The group is a leader in sustainable manufacturing practices. The main facilities are based in Vietnam. With over 4,300 personnel employed. Premium products are shipped globally for leading fashion houses. The company is one of the most environmentally friendly denim laundries manufactures in the world. It is currently the only bluesign certified laundry. Using technology, renewable energy, chemistry an innovative recycling programs for water, heat and waste. The company has reduced its energy usage by 5.4 million kilowatts of power per year. That's the equivalent of powering more that four hundred homes or taking 600 cars off the road. It has cut its energy consumption by more than half. Reduced C02 emissions by nearly 80%. Reduced water usage from 140liters of water per pair of jeans to 6 liters of water per jeans. Effectively reducing water consumption by 96%. Reduced its sludge content by 80% and figured out how to keep the sludge out of landfill. The company has done all this without compromising the quality of its washes or the craftsmanship of its denim. (Company E, 2015), Interview data)

### 4.2. Analysis & discussion

In 13 out of the 15 individuals interviewed, 13 mentioned the sustainability journey started by focusing on efficiency competency as the first critical step. These companies found efficiency to be the critical first step, with all 13 stating that staff awareness and training on developing the efficiency

competency was important to starting the journey. The specific skill of the ability to see the problem and understand the root causes was mentioned as important in 13 cases. Gaining attention and seeing the problem is commonly stated as the important first step to start seeing the different wastes.
Case A is found to develop the efficiency competency and the ability to see waste and systematically reduce it by promoting effective inter-company learning, by for example employing the power of kaizen (continuous) and the concept of Yokoten (sharing). To perform effective kaizen it is found, Knowledge of both the background and a good understanding of the process details is needed; "You can not make a decision on how to change something, if you really don't know that information. And also you need to know what the current situation is. For example, what is the current situation? You can only tell by actually going to the place where that process has worked, to understand how it is operating. We call this genchi genbutsu- 'go, see and study. And more importantly go and talk to the people who are operating those processes on a daily basis. They are the experts; the engineers are not the experts in this case. This can really only be performed effectively when you have a standardized process, you need the base of a standardized process to know whether your making a change in the right direction. You might make a change and if you don't have a control, you have no idea whether the result is going to be repeatable of not. A change for good can only be judged from a repeatable result. And you have to be prepared to be able to take controlled risk thorough controlled change, so you know what your anticipating and hope to achieve as a result." (Interview, Case A)

To perform effective Yokoten (Sharing); "need a certain number of things; we need a network, need a forum/opportunity enable sharing, mechanism /standardized format to communicate, motivation and recognition to encourage people to get involved in this type of activity. Also essential qualities are people need to be collaborative. We want people to be collaborative, we don't want people who want do things on their own, sit in a corner and get a good results, we need people to be able to be open and sharing. We want them to have a willingness to learn. We need this open to lateral thinking e.g. that's a good idea we saw over there, but how do I apply it over here, they don't have the same conditions. So you need some lateral thinking." (Interview, Case A). It appears the challenge is ability to seeing waste and having processes in place to become effective and systematic and reducing waste.

Case E is found to for every pair of jean another competitor laundry washes, the case company washes 23.3 jeans. That is a huge difference. "It took a lot of ingenuity and technology to achieve it. First the company got rid of its traditional belly washing machines that use 140 litres of water to wash each pair of jeans. The company now works with jet washing and jet dyeing machines, which only use a fraction of that water. Then the company collaborated (elicited) with some chemical scientist to find out how to combine the chemical processes in its washes. We obtained knowledge from experts to get better. Where another laundry takes 12 steps to reach a final wash, our organisation gets there is 6. Rather than discharging the wash water after using it. The company setup a water recycling plant. The system uses reverse osmosis, desalination and nano-filteration to recycle 96% of its water. Even the sludge gets recycled. Bricks are made from the sludge and can be used to make new buildings. Finally the company is developing a completely waterless wash by using a combination of ozone boosters. The company worked with chemical partners to develop and use wash chemicals that can be used at room temperature water and not heated water. Then the company installed a solar plant that uses renewable energy to heat 52,000 834.41 gallons of water per day. Then we figured out away to use reverse air engineering to recycle hot air from machinery to help dry denim. This is not only free but it also reduces the time garments need to spin in conventional driers. Through these and other energy-saving measures the company has been able to cuts its energy consumption in half. Saving them approximately 376,000$ annually on energy costs." (Interview, Case E)

The Case E example and evidence from all 6 case companies illustrates organisations reaching a certain level of maturity on the efficiency competency, once the organisation is able to see environmental and social waste and able to systematically reduce them. They are observed to be focusing on Internalisation & collaboration competency as next steps and techniques for finding solutions for improving sustainability performance further. From Case study B, the FMCG company has been able to transform all raw materials into value and products by being effective in internaliastion. It appears oganisations are able to co-create value and develop new business models through the internalisation competency mechanism. In Case B the opportunity thinking culture and waste nothing way of doing business is observed throughout the organization. "Those with the process knowledge are empowered to identify the innovations to be taken forward…. Collaboration with suppliers and other experts has been key to many of the improvements; from working with farmers to improve yield, optimise fertilizer use and extend the producing season, to collaborating with GE to optimise the operation of its CHP gas turbine. Careful consideration of when to partner, when to bring expertise in, and when to outsource new co-product operations has also underpinned the development of new lines of business." (Interview, Case B). Case C, the retailer is found to with new collaboration and relationships with a charity organisation (unusual partner) was able to implement a model called "shwopping" (buy one, give one culture). The evidence illustrates, organisations need to be able to visit a lot of stranger's organisations with different expertise and figure out which type of actors to bring into the system.

Case D is found to by taking a systems view to problem solving, and looking at the whole system and been successful in identifying useful interactions between the components. It is found the case companies approach to not practicing the normal problem solving technique, which is to break the problem to sub-problems and allocate it to subject experts. The holistic systems approach to problem solving has led to

the company to develop a radically new innovative business model. Where the car manufacture now sells mobility to customer and the manufacturer pays for the fuel. This unlocks a new value system that allows them to build 250 mpg(e) cars. It appears organisations that are comfortable in making the system boundary bigger and bring more variable into the system are able to find win-win interactions.

## 5. Conclusion

The research findings provide insights on organisations transforming from eco-efficiency to eco-effective system. The four competencies; 'efficiency', 'internalisation', 'collaboration and co-ordination' and 'whole system design' are identified from research as key competencies that aid the transformation. It is found that organisations focusing on the efficiency competency are able to see environmental and social waste and able to systematically reduce them. Organisations reaching a certain level of maturity on the efficiency competency and eco-efficiency stage, are found to be focusing on Internalisation & collaboration competency as next steps and techniques for finding solutions for improving sustainability performance further. Organisations that focus on Internalisation competency are found to be able to bring more value under their control by linking their knowledge to their benefit. A opportunity thinking culture and waste nothing way of doing is found to enable business model innovations in organsiations. Organisationations focusing of collaboration and coordinating competency are found to be able to work with partners up and down and outside the current value chain to improve sustainability performance and leverage new capability and knowledge from its partners. It is observed that leading organizations have been able to look for new variables, to find a new win-win interaction and focus on whole system design competency.

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